# pi_circle_estimation

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## 1 Estimation of Pi value with random points

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```
[1]: import numpy as np
     import plotly.graph_objects as go
     import plotly.io as pio
     pio.renderers.default = "notebook+pdf"
```

### 1.1 Calculation of n random numbers in a x[-2,2] y[-2,2] plane.

Pi value is aproximate with the number of points in a r=2 circle:

$$\pi = \frac{r^2}{area} \approx \frac{innerpoints}{totalpoints} r^2$$

```
[2]: numberPoints=2000
     points=np.random.rand(2,numberPoints)*4-2
     innerPoints=np.sum((points[0,:]**2+points[1,:]**2)<=4)
     print('Estimated pi is: '+str((innerPoints/numberPoints)*4))

     data1 = go.Scatter( x=points[0,:],y=points[1,:],mode='markers',name='Gaussian␣
      ↪test')

     layout = go.Layout(title='Random points')
     fig = go.Figure(data= data1, layout = layout)
     fig.update_xaxes(range=(-2,2), title='X')
     fig.update_yaxes(range=(-2,2),title='Y')
     fig.add_shape(type="circle",
         xref="x", yref="y",
         fillcolor="lightpink",
         x0=-2, y0=-2, x1=2, y1=2,
         line_color="LightSeaGreen",
         opacity=0.5,
         #layer="below"
```
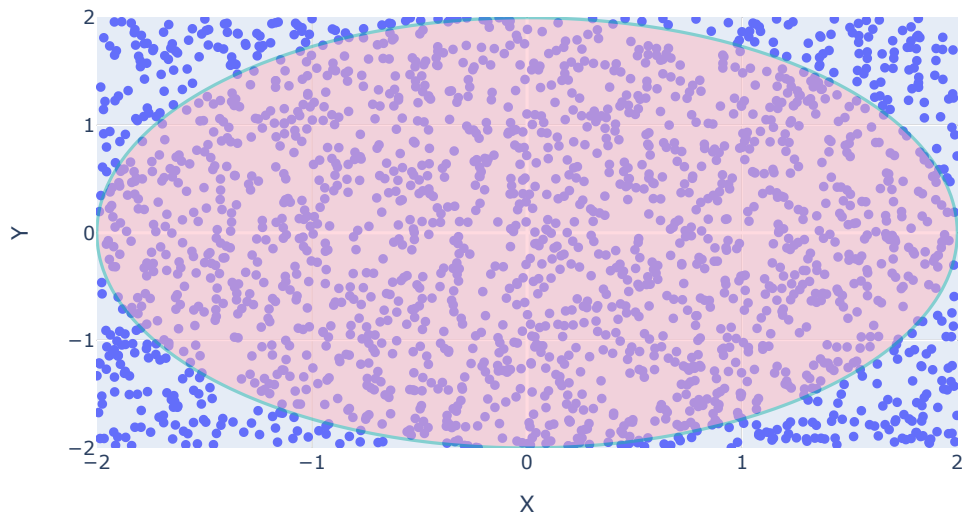
```
)
fig.show()
```

Estimated pi is: 3.108

Random points



## 1.2 Error of estimation

Error in function of the number of points.

$$Error = \mid \pi - \hat{\pi} \mid$$

```
[3]: pi=np.array(0)
numberPoints=500
for i,j in enumerate(range(1,numberPoints)):
    points=np.random.rand(2,j)*4-2
    innerPoints=np.sum((points[0,:]**2+points[1,:]**2)<=4)
    pi=np.append(pi,(innerPoints/j)*4)

error=np.abs(np.pi-pi)

data1 = go.Scatter( x=np.
 ↪linspace(1,numberPoints,numberPoints),y=pi,mode='lines',name='Abs. Error')
data = [data1]
layout = go.Layout(title='Abs. Error')
```

```
fig = go.Figure(data= data, layout = layout)
fig.update_xaxes(title='Number of points')
fig.update_yaxes(title='Abs. Error')
fig.show()
```

Abs. Error